

The 1st Conference
on Positive Youth
Development in a
Cross-national
Perspective



Workshop 2: Factor Analysis and Measurement Invariance

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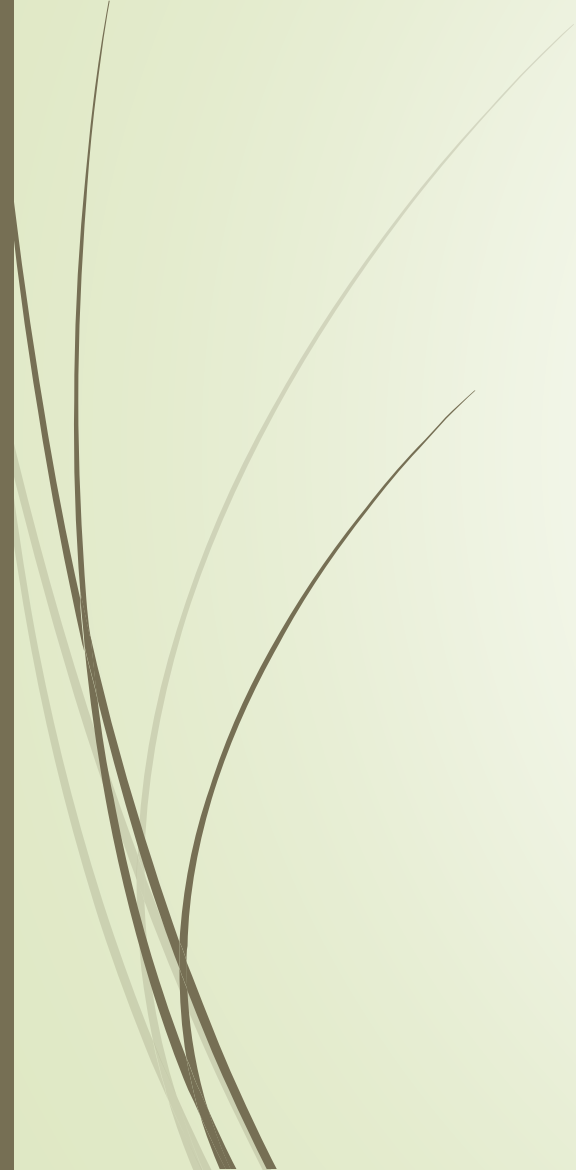
Universidad
de Huelva





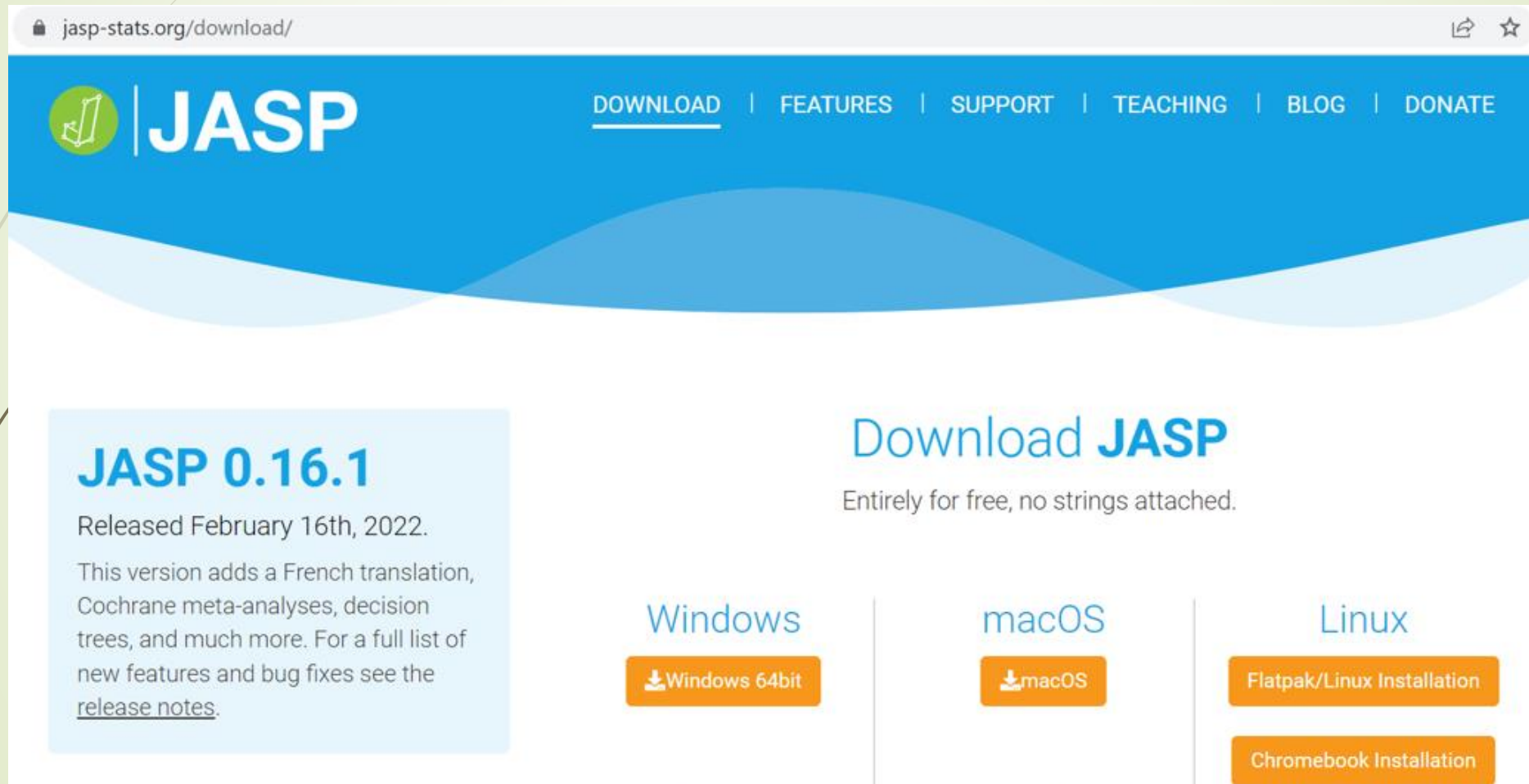
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Part 1

JASP statistical package



The image shows a screenshot of the JASP website's download page. The browser address bar shows 'jasp-stats.org/download/'. The page has a blue header with the JASP logo and navigation links: DOWNLOAD, FEATURES, SUPPORT, TEACHING, BLOG, and DONATE. The main content area features a light blue box on the left with the text 'JASP 0.16.1' and 'Released February 16th, 2022.' Below this, it describes the new features and points to the release notes. To the right, the heading 'Download JASP' is followed by the text 'Entirely for free, no strings attached.' Below this, there are three columns for different operating systems: Windows, macOS, and Linux. Each column contains an orange button with a download icon and the specific installation method for that OS.

jasp-stats.org/download/

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JASP 0.16.1

Released February 16th, 2022.

This version adds a French translation, Cochrane meta-analyses, decision trees, and much more. For a full list of new features and bug fixes see the [release notes](#).

Download JASP

Entirely for free, no strings attached.

<h3>Windows</h3> <p>Windows 64bit</p>	<h3>macOS</h3> <p>macOS</p>	<h3>Linux</h3> <p>Flatpak/Linux Installation</p> <p>Chromebook Installation</p>
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Starting with Jasp

- ▶ Open, Computer, Browse. Then, select the .sav or .xls file.
- ▶ You can save the new jasp data file.

The screenshot displays the JASP software interface. The top menu bar includes options like Descriptives, T-Tests, ANOVA, Mixed Models, Regression, Frequencies, Factor, Equivalence T-Tests, Reliability, SEM, and R (Beta). The left sidebar contains menu items such as Open, Save, Save As, Export Results, Export Data, Sync Data, Close, Preferences, and About. The main workspace shows a 'Recent Files' list with 'Computer' selected, and a 'Recent Folders' section with a 'Browse' button. An 'Open' file explorer window is overlaid, showing the path 'Escritorio > workshop bergem'. The file list includes folders like 'ejemplos de measurement invariance' and 'PYD_workshop', and files named 'PYD_workshop'. The file type is set to 'Data Sets (*.jasp *.csv *.txt *.tsv)'. The system tray at the bottom shows the date as 02/04/2022 and the time as 11:00.

Descriptive statistics

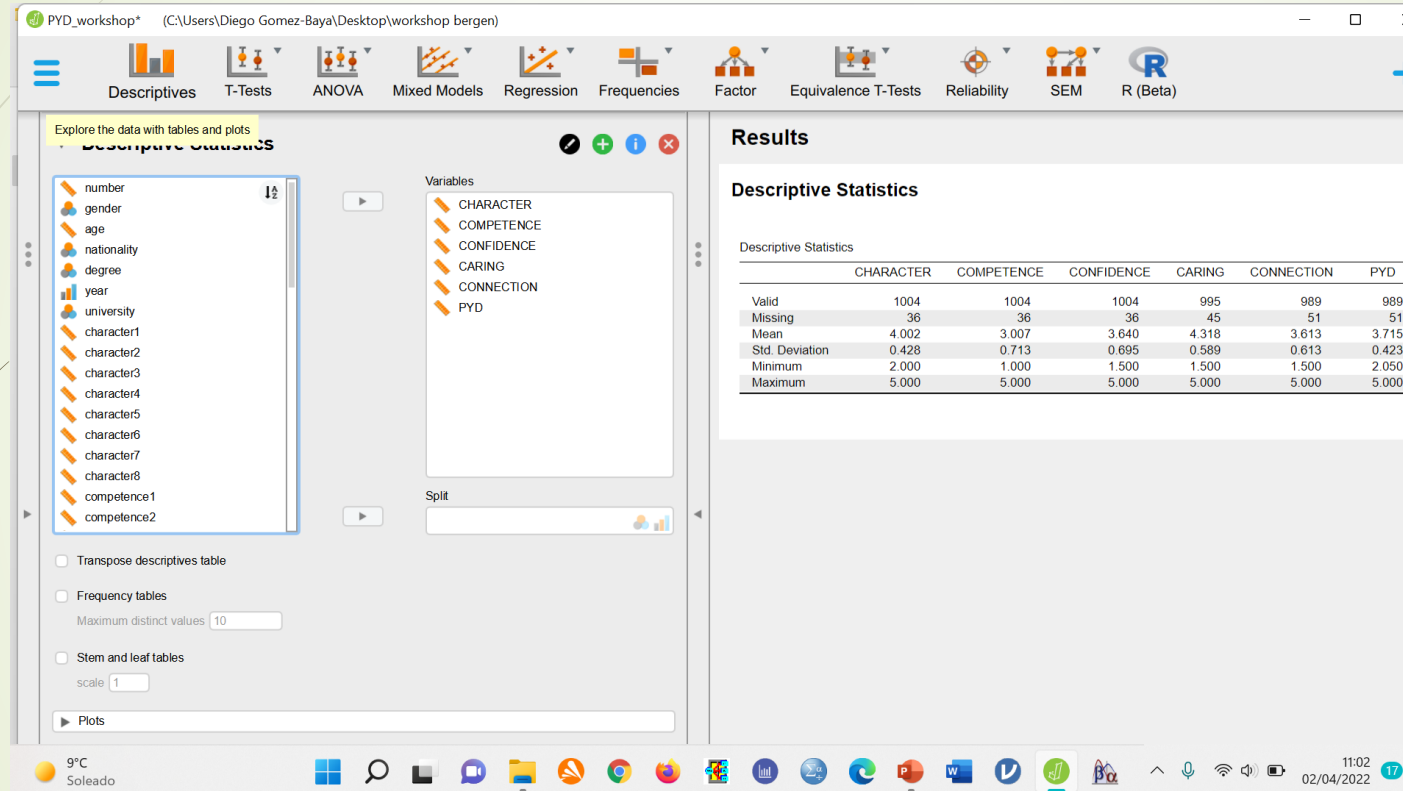


Table 1 shows descriptive statistics of the 5Cs and the overall score in PYD. The scores could range between 1 and 5, so that mean scores over 3 indicate a positive development of the dimension. Moderate to high mean scores were observed in the 5Cs. The highest scores were found in caring and character, while the lowest was observed in competence.

Export tables in APA format

The screenshot displays the SPSS software interface. The top menu bar includes options like Descriptives, T-Tests, ANOVA, Mixed Models, Regression, Frequencies, Factor, Equivalence T-Tests, Reliability, SEM, and R (Beta). The main window is titled 'PYD_workshop*' and shows the 'Descriptive Statistics' dialog box on the left and the 'Results' window on the right.

Descriptive Statistics Dialog Box:

- Variables:** CHARACTER, COMPETENCE, CONFIDENCE, CARING, CONNECTION, PYD
- Options:** Transpose descriptives table (unchecked), Frequency tables (unchecked), Stem and leaf tables (unchecked), Plots (unchecked)

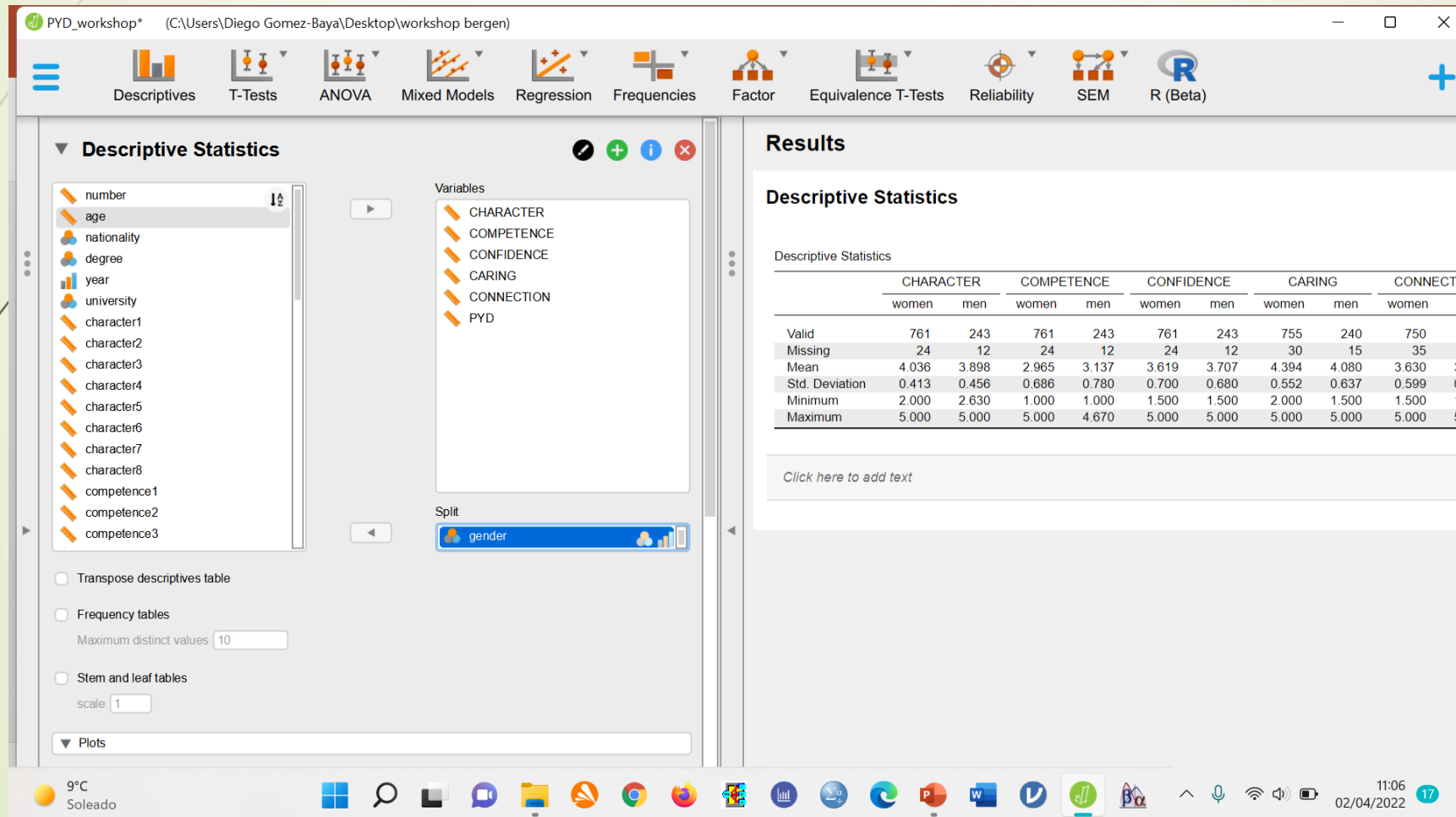
Results - Descriptive Statistics:

	CHARACTER	CONFIDENCE	CARING	CONNECTION	PYD
Valid	1004	1004	995	989	989
Missing	36	36	45	51	51
Mean	4.002	3.640	4.318	3.613	3.715
Std. Deviation	0.428	0.695	0.589	0.613	0.423
Minimum	2.000	1.000	1.500	1.500	1.500
Maximum	5.000	5.000	5.000	5.000	5.000

A context menu is open over the table, showing options: Edit Title, Copy, Copy Citations, Add Note, Duplicate, and Remove.

System tray at the bottom shows: 9°C Soleado, taskbar icons, and system clock: 11:04 02/04/2022 17.

How to Split the sample in descriptive stats



The screenshot shows the SPSS software interface. The 'Descriptive Statistics' dialog box is open, with the 'Split' section selected and 'gender' chosen. The 'Results' window displays the following table:

	CHARACTER		COMPETENCE		CONFIDENCE		CARING		CONNECTI
	women	men	women	men	women	men	women	men	women
Valid	761	243	761	243	761	243	755	240	750
Missing	24	12	24	12	24	12	30	15	35
Mean	4.036	3.898	2.965	3.137	3.619	3.707	4.394	4.080	3.630
Std. Deviation	0.413	0.456	0.686	0.780	0.700	0.680	0.552	0.637	0.599
Minimum	2.000	2.630	1.000	1.000	1.500	1.500	2.000	1.500	1.500
Maximum	5.000	5.000	5.000	4.670	5.000	5.000	5.000	5.000	5.000

T-tests

Independent Samples T-Test

Dependent Variables: CHARACTER, COMPETENCE, CONFIDENCE, CARING, CONNECTION

Grouping Variable: gender

Tests: Student, Welch, Mann-Whitney

Additional Statistics: Location parameter, Confidence interval (95.0 %), Effect size (Cohen's d), Glass' delta, Hedges' g, Confidence interval (95 %), Descriptives, Descriptives plots, Raincloud plots, Horizontal display, Vovk-Selkoe maximum p-ratio

Alt. Hypothesis: Group 1 ≠ Group 2, Group 1 > Group 2, Group 1 < Group 2

Independent Samples T-Test

	t	df	p	Cohen's d
CHARACTER	4.400	1002	< .001	0.324
COMPETENCE	-3.301	1002	< .001*	-0.243
CONFIDENCE	-1.711	1002	0.087	-0.126
CARING	7.382	993	< .001*	0.547
CONNECTION	1.574	987	0.116*	0.117

Note. Student's t-test.
* Levene's test is significant (p < .05), suggesting a violation of the equal variance assumption.

Descriptives

Group Descriptives		Group	N	Mean	SD	SE
CHARACTER	women	761	4.036	0.413	0.015	
	men	243	3.898	0.456	0.029	
COMPETENCE	women	761	2.965	0.686	0.025	
	men	243	3.137	0.780	0.050	
CONFIDENCE	women	761	3.619	0.700	0.025	
	men	243	3.707	0.680	0.044	
CARING	women	755	4.394	0.552	0.020	
	men	240	4.080	0.637	0.041	
CONNECTION	women	750	3.630	0.599	0.022	
	men	239	3.559	0.654	0.042	

➔ T-Tests, Independent samples t-tests, select variables, grouping variable: gender, Tests: Student, Effect size: Cohen's d, Descriptive.

➔ Some gender differences were observed in some PYD dimensions. Men presented greater scores in competence, $t(1002) = -3.30$, $p < .001$, $d = .244$, while women showed more character, $t(1002) = 4.40$, $p < .001$, $d = .324$, and more caring, $t(993) = 7.38$, $p < .001$, $d = .547$.

Reliability: Internal consistency

- ▶ With the items of each subscale we can calculate the internal consistency:
- ▶ Reliability, Classical, Unidimensional reliability. Include the items and select Cronbach Alpha, Cronbach Alpha (if item dropped) and item-rest correlation

The screenshot shows the SPSS Unidimensional Reliability analysis interface. On the left, a list of variables includes 'confidence3' through 'confidence6' and 'caring1' through 'caring6'. The 'Variables' list on the right contains 'connection1' through 'connection8'. The 'Analysis' section is set to 'Scale Statistics' with 'Confidence Interval' at 95.0%, 'Cronbach's α ', and 'Item-rest correlation' selected. The 'Results' pane displays the following data:

Frequentist Scale Reliability Statistics	
Estimate	Cronbach's α
Point estimate	0.770
95% CI lower bound	0.748
95% CI upper bound	0.791

Frequentist Individual Item Reliability Statistics		
Item	If item dropped	
	Cronbach's α	Item-rest correlation
connection1	0.746	0.473
connection2	0.731	0.563
connection3	0.733	0.539
connection4	0.754	0.424
connection5	0.744	0.481
connection6	0.747	0.466
connection7	0.751	0.439
connection8	0.758	0.396

Concerning reliability, acceptable internal consistency was detected in the dimension of connection ($\alpha = .77$). All correlations between the separate items and the rest of the scale are high and positive. Alpha score did not improve after removing any indicator.

Cronbach's Coefficient Alpha (α)	Reliability
0.80 to 0.95	Very Good
0.70 to 0.80	Good
0.60 to 0.70	Fair
< 0.60	Poor

Exploratory factor analysis

- Factor, Principal component analysis, select the variables, Rotation (Orthogonal, Varimax), Manual: Number of factors:1, Highlight =0:

The screenshot displays the SPSS software interface for a Principal Component Analysis. The 'Variables' list includes CHARACTER, COMPETENCE, CONFIDENCE, CARING, and CONNECTION. The 'Number of Components' is set to 1, and the 'Rotation' method is 'Orthogonal' with 'varimax' selected. The 'Results' pane shows a Chi-squared Test with a value of 450.227, 5 degrees of freedom, and a p-value less than .001. The 'Component Loadings' table shows the following values:

	PC1	Uniqueness
CONFIDENCE	0.811	0.343
CONNECTION	0.799	0.362
COMPETENCE	0.748	0.441
CHARACTER	0.701	0.509
CARING	0.352	0.876

The 'Component Characteristics' table shows the following values for Component 1:

	Unrotated solution			Rotated solution		
	Eigenvalue	Proportion var.	Cumulative	SumSq. Loadings	Proportion var.	Cumulative
Component 1	2.469	0.494	0.494	2.469	0.494	0.494

Principal component analysis was conducted, $\chi^2(10) = 450.23, p < .001$. The results indicated one factor with high percentage of explained variance (Eigenvalue = 2.47, % explained variance = 49.4). Four variables showed components loading over 0.70, while caring presented a very low loading. The PYD factor could be composed of four dimensions.

Confirmatory factor analysis

- Factor, Confirmatory factor analysis, Select variables (confidence, connection, competence and character), Additional output (additional fit measures, R squared, modification indices)

The screenshot displays the SPSS Confirmatory Factor Analysis (CFA) interface. The main window is titled "Confirmatory Factor Analysis" and shows a list of variables on the left, including "CHARACTER", "COMPETENCE", "CONFIDENCE", "CONNECTION", "social_contribution", "depression", "anxiety", "life_satisfaction", "PYD", "dep_clin", "anx_clin", and "age_cat". The "Factor 1" box contains "CHARACTER", "COMPETENCE", "CONFIDENCE", and "CONNECTION". The "Additional Output" section is checked for "Additional fit measures", "R-Squared", and "Modification indices". The "Cutoff" is set to 3.84. The right panel shows the "Confirmatory Factor Analysis" results, including the "Model fit" table and "Additional fit measures" table.

Model	X ²	df	p
Baseline model	1124.598	6	
Factor model	35.695	2	< .001

Index	Value
Comparative Fit Index (CFI)	0.970
Tucker-Lewis Index (TLI)	0.910
Bentler-Bonett Non-normed Fit Index (NNFI)	0.910
Bentler-Bonett Normed Fit Index (NFI)	0.968
Parsimony Normed Fit Index (PNFI)	0.323
Bollen's Relative Fit Index (RFI)	0.905
Bollen's Incremental Fit Index (IFI)	0.970
Relative Noncentrality Index (RNI)	0.970

Information criteria	Value
Log-likelihood	-3052.893
Number of free parameters	8.000
Akaike (AIC)	6121.786
Bayesian (BIC)	6160.050

Confirmatory factor analysis

The screenshot displays the Mplus software interface for a Confirmatory Factor Analysis (CFA) model. The model is a single-factor model with four indicators: CHARACTER, COMPETENCE, CONFIDENCE, and CONNECTION. The results are presented in several panels:

- Other fit measures:**

Metric	Value
Root mean square error of approximation (RMSEA)	0.131
RMSEA 90% CI lower bound	0.095
RMSEA 90% CI upper bound	0.170
RMSEA p-value	1.487e-4
Standardized root mean square residual (SRMR)	0.034
Hoelter's critical N ($\alpha = .05$)	167.003
Hoelter's critical N ($\alpha = .01$)	256.188
Goodness of fit index (GFI)	0.983
McDonald fit index (MFI)	0.983
Expected cross validation index (ECVI)	0.052
- R-Squared:**

Indicator	R ²
CHARACTER	0.257
COMPETENCE	0.501
CONFIDENCE	0.687
CONNECTION	0.474
- Parameter estimates (Factor loadings):**

Factor	Indicator	Symbol	Estimate	Std. Error	z-value	p	95% Confidence Interval	
							Lower	Upper
Factor 1	CHARACTER	λ_{11}	0.216	0.014	15.428	< .001	0.189	0.244
	COMPETENCE	λ_{12}	0.504	0.022	22.798	< .001	0.461	0.548
	CONFIDENCE	λ_{13}	0.579	0.021	27.349	< .001	0.538	0.621
	CONNECTION	λ_{14}	0.422	0.019	22.102	< .001	0.385	0.459
- Factor variances:**

Factor	Estimate	Std. Error	z-value	p	95% Confidence Interval	
					Lower	Upper
Factor 1	1.000	0.000			1.000	1.000
- Residual variances:**

Indicator	Estimate	Std. Error	z-value	p	95% Confidence Interval	
					Lower	Upper
CHARACTER	0.135	0.007	20.434	< .001	0.122	0.148
COMPETENCE	0.254	0.015	16.514	< .001	0.224	0.284
CONFIDENCE	0.153	0.015	10.465	< .001	0.124	0.182
CONNECTION	0.197	0.012	17.166	< .001	0.175	0.220
- Modification Indices (Residual covariances):**

Indicator 1	Indicator 2	Mod. Ind.	EPC
CONFIDENCE	CONNECTION	32.047	-0.097
CHARACTER	COMPETENCE	32.047	-0.043
COMPETENCE	CONFIDENCE	11.232	0.070
CHARACTER	CONNECTION	11.232	0.022
CHARACTER	CONFIDENCE	4.907	0.018
COMPETENCE	CONNECTION	4.907	0.031

➔ Confirmatory factor analysis was performed with four components of PYD, as indicated by previous analysis (i.e, competence, confidence, connection and character). Poor data fit was observed in some indices, $\chi^2(2) = 35.70$, $p < .001$, CFI = .970, RMSEA = .13. Modification indices suggested a residual covariance between character and competence.

Confirmatory factor analysis

The screenshot shows the Mplus software interface for a confirmatory factor analysis. The window title is "PYD_workshop* (C:\Users\Diego Gomez-Baya\Desktop\workshop bergen)". The menu bar includes options: Descriptives, T-Tests, ANOVA, Mixed Models, Regression, Frequencies, Factor, Equivalence T-Tests, Reliability, SEM, and R (Beta). The main window is divided into several sections:

- Model Options:** Includes checkboxes for "Include mean structure" and "Assume factors uncorrelated". The "Factor Scaling" is set to "Factor variances".
- Residual Covariances:** A list of variables (CHARACTER, COMPETENCE, CONFIDENCE, CONNECTION) is shown. A blue box highlights the selection of CHARACTER and COMPETENCE.
- Additional Output:** Checkboxes for "Additional fit measures" and "R-Squared" are checked. Other options like "Implied covariance matrix", "Residual covariance matrix", "Modification indices", and "Cutoff" (3.84) are also visible.
- Results Panel:** Displays several tables of statistical results.

Table 1: Factor Loadings

Indicator	λ	Estimate	Std. Error	z-value	p	Lower	Upper
COMPETENCE	λ12	0.504	0.022	22.798	< .001	0.461	0.548
CONFIDENCE	λ13	0.579	0.021	27.349	< .001	0.538	0.621
CONNECTION	λ14	0.422	0.019	22.102	< .001	0.385	0.459

Table 2: Factor variances

Factor	Estimate	Std. Error	z-value	p	Lower	Upper
Factor 1	1.000	0.000			1.000	1.000

Table 3: Residual variances

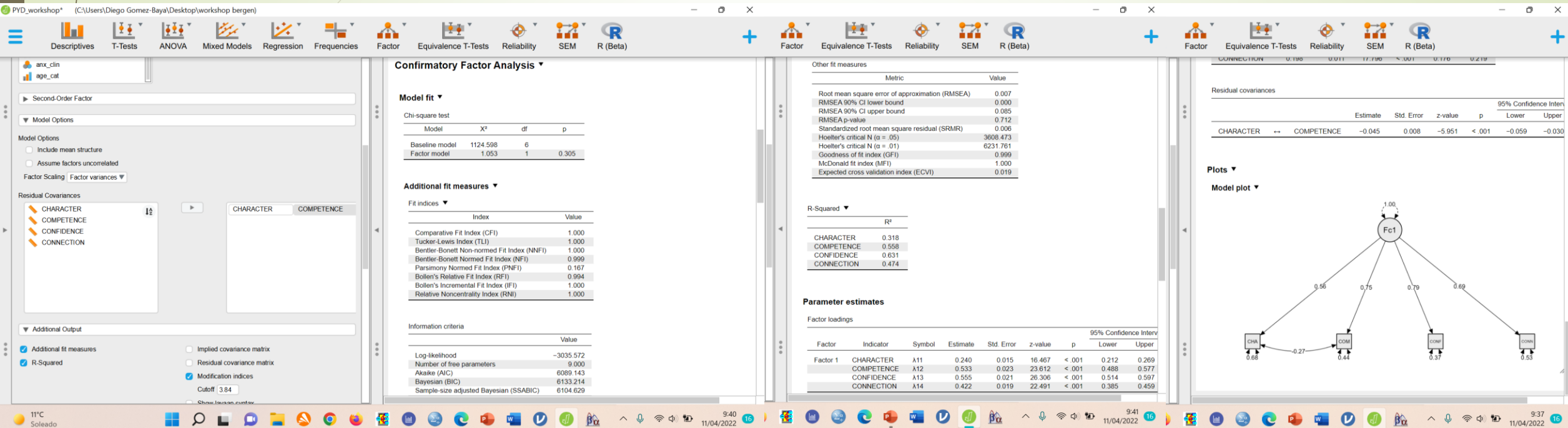
Indicator	Estimate	Std. Error	z-value	p	Lower	Upper
CHARACTER	0.135	0.007	20.434	< .001	0.122	0.148
COMPETENCE	0.254	0.015	16.514	< .001	0.224	0.284
CONFIDENCE	0.153	0.015	10.465	< .001	0.124	0.182
CONNECTION	0.197	0.012	17.166	< .001	0.175	0.220

Table 4: Modification Indices

Residual covariances	Mod. Ind.	EPC
CONFIDENCE ↔ CONNECTION	32.047	-0.097
CHARACTER ↔ COMPETENCE	32.047	-0.043
COMPETENCE ↔ CONFIDENCE	11.232	0.070
CHARACTER ↔ CONNECTION	11.232	0.022
CHARACTER ↔ CONFIDENCE	4.907	0.018
COMPETENCE ↔ CONNECTION	4.907	0.031

- Model options: Residual covariances: Select the pair of variables
- Plots, model plot, standardized

Confirmatory factor analysis



- After the modification, the model improved the data fit and reached acceptable values, $\chi^2(1) = 1.05$, $p = .305$, $CFI = 1$, $RMSEA = .007$, $90\% \text{ CI } RMSEA = .000 - .085$, $SRMR = .006$. Standardized solutions showed Good factor loadings by competence ($\beta = .75$) and confidence ($\beta = .79$), and moderated ones by connection ($\beta = .69$) and character ($\beta = .56$). Residual covariance between competence and character was significant ($\beta = -.27$). A four factor model of PYD reached good data fit.

Measurement invariance

The screenshot displays the Mplus software interface. On the left, the 'Multigroup CFA' section is active, with 'Invariance testing' set to 'Configural'. A dropdown menu is open, showing a list of variables including 'number', 'gender', 'age', 'nationality', 'degree', 'year', 'university', and several 'character' and 'competence' variables. The 'Confirmatory Factor Analysis' results are shown on the right, including a table for the Chi-square test and a table for additional fit measures.

Model	X ²	df	p
Baseline model	1124.598	6	
Factor model	1.053	1	0.305

Index	Value
Comparative Fit Index (CFI)	1.000
Tucker-Lewis Index (TLI)	1.000
Bentler-Bonett Non-normed Fit Index (NNFI)	1.000
Bentler-Bonett Normed Fit Index (NFI)	0.999
Parsimony Normed Fit Index (PNFI)	0.167
Bollen's Relative Fit Index (RFI)	0.994
Bollen's Incremental Fit Index (IFI)	1.000
Relative Noncentrality Index (RNI)	1.000

➤ Multigroup CFA, Grouping variable (select gender, for example), Invariance testing:

- Configural: Same structure across groups
- Metric: same factor loading across groups
- Scalar: same intercepts across groups
- Strict: same residual variances across groups

[Chen \(2007\)](#) suggested a criterion of a -.01 change in CFI, paired with changes in RMSEA of .015 and SRMR of .030 (for metric invariance) or .015 (for scalar or residual invariance). Strict measurement invariance is not considered necessary in cross-cultural research.

Measurement invariance

The screenshot displays the Mplus software interface for a Multigroup CFA model. The left sidebar shows the following settings:

- R-Squared
- Residual covariance matrix
- Modification indices
- Cutoff: 3.84
- Show lavaan syntax
- Multigroup CFA
- Grouping variable: gender
- Invariance testing: Configural
- Plots: Misfit plot, Model plot, Show parameters, Standardized, Show means
- Advanced: (empty)
- Emulation: None, Mplus, EQS
- Error calculation: CI width: 95.0 %, Method: Standard, Robust, Bootstrap CI, Bootstrap samples: 1000
- Estimator: Auto, None
- Standardization: None

The central panel displays the following fit indices:

Index	Value
Comparative Fit Index (CFI)	1.000
Tucker-Lewis Index (TLI)	1.009
Bentler-Bonett Non-normed Fit Index (NNFI)	1.009
Bentler-Bonett Normed Fit Index (NFI)	1.000
Parsimony Normed Fit Index (PNFI)	0.167
Bollen's Relative Fit Index (RFI)	0.998
Bollen's Incremental Fit Index (IFI)	1.001
Relative Noncentrality Index (RNI)	1.001

The bottom panel displays the following information criteria:

	Value
Log-likelihood	-2995.538
Number of free parameters	18.000
Akaike (AIC)	6027.077
Bayesian (BIC)	6115.217
Sample-size adjusted Bayesian (SSABIC)	6058.049

The right panel displays the following additional fit measures:

Index	Value
Comparative Fit Index (CFI)	1.000
Tucker-Lewis Index (TLI)	1.000
Bentler-Bonett Non-normed Fit Index (NNFI)	1.000
Bentler-Bonett Normed Fit Index (NFI)	0.996
Parsimony Normed Fit Index (PNFI)	0.415
Bollen's Relative Fit Index (RFI)	0.990
Bollen's Incremental Fit Index (IFI)	1.000
Relative Noncentrality Index (RNI)	1.000

The bottom right panel displays the following other fit measures:

Metric	Value
Root mean square error of approximation (RMSEA)	0.000
RMSEA 90% CI lower bound	0.000
RMSEA 90% CI upper bound	0.061
RMSEA p-value	0.880
Standardized root mean square residual (SRMR)	0.026
Hoeller's critical N ($\alpha = .05$)	2279.142
Hoeller's critical N ($\alpha = .01$)	3105.529
Goodness of fit index (GFI)	0.998

➤ No remarkable differences by gender were observed in the structure and factor loadings.

Measurement invariance

The screenshot displays the LISREL 8.80.000 software interface, showing the results of a measurement invariance analysis. The interface is divided into several panels: a left sidebar with analysis options, a central results panel, and a right sidebar with additional fit measures. The central panel shows the results for three models: Multigroup CFA, Scalar, and Strict. The results are presented in tables for Fit indices, Information criteria, and Other fit measures.

Multigroup CFA

Grouping variable: gender
Invariance testing: Scalar

Fit indices

Index	Value
Comparative Fit Index (CFI)	0.964
Tucker-Lewis Index (TLI)	0.946
Bentler-Bonett Non-normed Fit Index (NNFI)	0.946
Bentler-Bonett Normed Fit Index (NFI)	0.957
Parsimony Normed Fit Index (PNFI)	0.638
Bollen's Relative Fit Index (RFI)	0.936
Bollen's Incremental Fit Index (IFI)	0.964
Relative Noncentrality Index (RNI)	0.964

Information criteria

	Value
Log-likelihood	-3020.153
Number of free parameters	20.000
Akaike (AIC)	6080.306
Bayesian (BIC)	6178.239
Sample-size adjusted Bayesian (SSABIC)	6114.719

Other fit measures

Metric	Value
Root mean square error of approximation (RMSEA)	0.103
RMSEA 90% CI lower bound	0.076
RMSEA 90% CI upper bound	0.131
RMSEA p-value	7.570e-4
Standardized root mean square residual (SRMR)	0.046
Hoeller's critical N ($\alpha = .05$)	310.298
Hoeller's critical N ($\alpha = .01$)	401.705
Goodness of fit index (GFI)	0.999

Scalar

Invariance testing: Strict

Fit indices

Index	Value
Comparative Fit Index (CFI)	0.943
Tucker-Lewis Index (TLI)	0.948
Bentler-Bonett Non-normed Fit Index (NNFI)	0.948
Bentler-Bonett Normed Fit Index (NFI)	0.948
Parsimony Normed Fit Index (PNFI)	1.010
Bollen's Relative Fit Index (RFI)	0.936
Bollen's Incremental Fit Index (IFI)	0.943
Relative Noncentrality Index (RNI)	0.943

Information criteria

	Value
Log-likelihood	-3034.339
Number of free parameters	15.000
Akaike (AIC)	6098.677
Bayesian (BIC)	6172.128
Sample-size adjusted Bayesian (SSABIC)	6124.487

Other fit measures

Metric	Value
Root mean square error of approximation (RMSEA)	0.101
RMSEA 90% CI lower bound	0.080
RMSEA 90% CI upper bound	0.123
RMSEA p-value	6.162e-5
Standardized root mean square residual (SRMR)	0.054
Hoeller's critical N ($\alpha = .05$)	284.693
Hoeller's critical N ($\alpha = .01$)	352.264
Goodness of fit index (GFI)	0.999

➤ Remarkable differences were found in the intercept ($\Delta\text{CFI} = .036$, $\Delta\text{RMSEA} = .103$, $\Delta\text{SRMR} = .041$) and in the residual variances ($\Delta\text{CFI} = .057$, $\Delta\text{RMSEA} = .101$, $\Delta\text{SRMR} = .049$). Thus, the model showed measurement invariance at configural and metric level, while differences were detected in scalar and strict analyses.